SECTION 6-02, CONCRETE STRUCTURES
May 28, 1996

Sections 6-02.1 through 6-02.3(6)D, except Table 6-02.3(6), are deleted in their entirety and are replaced by the following new Sections 6-02.1 through 6-02.3(6)D, including a new Contracting Agency-Provided Mix Designs chart.

6-02.1 Description
Section 6-02 applies to the construction of all structures (and their parts) made of Portland cement concrete with or without reinforcement. Any part of a structure to be made of other materials shall be built as these Specifications require elsewhere.

6-02.2 Materials
Materials shall meet the requirements of the following sections:

Portland Cement	9-01
Aggregates for Portland Cement Concrete	9-03.1
Gravel Backfill	9-03.12
Joint and Crack Sealing Materials	9-04
Reinforcing Steel	9-07
Epoxy-Coated Reinforcing Steel	9-07
Prestressed Concrete Girders	9-19
Curing Materials and Admixtures	9-23
Fly Ash	9-23
Plastic Waterstop	9-24
Water	9-25
Elastomeric Bearing Pads	9-31

6-02.3 Construction Requirements
6-02.3(1) Classification of Structural Concrete
The class of concrete to be used shall be as noted in the Plans and these Specifications. The numerical class of concrete defines the specified compressive strength at 28 days. The letter designations following the class of concrete identify specific uses.

LS for Low Shrink applications
P for Piling applications
W for Underwater applications
D for Deck applications

The Contractor may request, in writing, permission to use a class of concrete with a higher compressive strength than specified. The substitute concrete shall be evaluated for acceptance based on the specified class of concrete. The Engineer will respond in writing. The Contractor shall bear any added costs that result from the change.

6-02.3(2) Proportioning Materials
The total Chloride ion (Cl-) content of the mixed concrete shall not exceed 0.06 percent of cementitious material for prestressed concrete nor 0.10 percent of cementitious material for reinforced concrete. Cementitious material shall be the weight of cement plus fly ash and microsilica, if used.

Concrete for bridge decks, bridge approach slabs, and for Contracting Agency-provided mixes shall use only Class 1 fine aggregate. Concrete for slip-formed barrier may use Class 1 or 2 fine aggregate.

Unless otherwise specified, the Contractor shall use Type I or II Portland cement in all concrete.

The use of fly ash for all classes of concrete other than for Contracting Agency-provided mixes is optional. Fly ash, if used, shall not exceed 25 percent by weight of the total cementitious material in the concrete mix and all concrete within a class in a structure shall have the same proportion of fly ash. The water/cement ratio shall be calculated on the total cementitious material.

As an alternative to the use of cement and fly ash as separate components, a blended hydraulic cement, Type IP(MS) or Type I (PM) (MS), may be used. The blended cement shall be produced such that the maximum fly ash content of the cementitious material is 25 percent.

6-02.3(2)A Contractor-Provided Mix Design

The Contractor shall provide a mix design for concrete Classes 5000, 5000LS, and higher. For all other classes of concrete, the Contractor may provide an alternate mix design to the Contracting Agency-Specified mix design. If the Contractor elects to provide an alternative for Class 4000P or Class 4000D, the proposed mix shall provide a minimum fly ash content per cubic yard of 100 lbs. and 75 lbs. respectively.

For concrete designated as LS (Low Shrink) or concrete designated as W (underwater placement), the maximum water/cement ratio shall be as shown in Section 6-02.3(2)C. For concrete Classes 5000LS and 6000LS, the Contractor-provided mix design water cement ratio shall not exceed 0.36.

The Contractor's submittal of a mix design shall provide a unique identification for each mix design and shall include the mix proportions per cubic yard and the proposed sources. Concrete placeability, workability, and strength shall be the responsibility of the Contractor. The Contractor shall notify the Engineer in writing of any mix design weight modifications.

Fine aggregate shall conform to Section 9-03.1(2) Class 1 or Class 2.

Coarse aggregate shall conform to Section 9-03.1(3), Grading No. 2, 5, or 6, or to Section 9-03.1(4). The nominal maximum size aggregate shall be 3/4 inch for all classes except Class 3000, 4000P, and 4000W. The nominal maximum size aggregate for Class 3000 and 4000W shall be 11/2 inches. The nominal maximum size aggregate for Class 4000P shall be 1/2 inch.

Water reducing/retarding admixture for concrete Class 4000P shall conform to the requirements of Section 9-23.6 Type D. High range water reducing admixtures shall conform to the requirements of Section 9-23.6 Type G.

6-02.3(2)B Commercial Concrete

Where concrete Class 3000 is specified for nonstructural items; such as, culvert headwalls, plugging culverts, concrete pipe collars, pipe anchors, luminaire bases,

pedestals, cabinet bases, guardrail anchors, sign post foundations, fence post footings, sidewalks, curbs, and gutters the Contractor may use commercial concrete. Commercial class concrete shall not be used for bridges, retaining walls, box culverts, or foundations for high mast luminaires, mast arm traffic signals, cantilever signs, and sign bridges. For items not listed, the Contractor may use commercial concrete if approved by the Engineer.

Commercial class concrete shall conform to the following:

Specified Compressive Strength at 28 days, minimum	3000	psi
Cementitious Material, Pounds per Cubic Yard, minimum (Not more than 25% of cementitious material may be fly ash.)	500	pounds
Coarse Aggregate Nominal Maximum Size	11/2	inch
Fine Aggregate	Class 1 or 2	

For commercial concrete, the Contractor may use mobile mixers that measure material by volume.

Contracting Agency-Provided Mix Designs

	CL3000	CL3000 W/Air	CL3000LS W/Air	CL4000	CL4000 W/Air	CL4000W	CL4000LS W/Air	CL4000D W/Air	CL4000DLS W/Air	CL4000P
28 Day Strength(psi)	3000	3000	3000	4000	4000	4000	4000	4000	4000	4000
Pounds per Cubic Yard										
Cement	540	540	540	660	660	660	660	660	660	610
Fly Ash								75	75	100
Fine Aggregate Class 1	1315	1100	1130	1305	1090	1350	1130	1100	1175	
Fine Aggregate Class 2										1160
Coarse Aggregate #2	1950	1950	1990			See Note 3				
Coarse Aggregate #5				1800	1800	See Note 3	1870	1700	1700	
Coarse Aggregate #6										1850
Coarse Aggregate #8										
Max. Water	270	270	245	290	290	250	250	290	265	300
Max Water/ Cement Ratio	0.50	0.50	0.45	0.44	0.44	0.38	0.38	0.39	0.36	0.42
% Entrained Air		6	6		6		6	6	6	
Water Reducer Type A	Optnl	Optnl	Req'd	See Note 2	See Note 2	Req'd	Req'd	Req'd	Req'd	
Water Reducer/ Ret. Type D								Optnl	Optnl	Req'd
Water Reducer Type F or G										See Note 1

References Aggregate Weights Based on Specific Gravity of 2.67.
Actual weights will be adjusted for varying Specific Gravities, yield and cement content.

Note 1: See 6-02.3(3)D

Note 2: Required where aggregate qualification is based on use of water reducer

Note 3: 1870 pounds of either Coarse Agg #2 or Coarse Agg #5

6-02.3(2)C Contracting Agency-Provided Mix Designs

The specified compressive strength at 28 days and mix proportions for the Contracting Agency-provided mix designs are listed in the Contracting Agency-provided mix design chart.

6-02.3(2)D Lean Concrete

Lean concrete shall meet the following requirements:

Ingredients	Amount per Cu. Yd.
Portland cement	145 to 200 pounds
Fine aggregate Class 1 or 2	3,400 pounds

Coarse aggregate may be substituted for up to 50% of the fine aggregate.

Slump 6 to 9 inches

If requested by the Contractor, the proportions may be adjusted with the approval of the Engineer.

6-02.3(3) Admixtures

Concrete admixtures shall be added to the concrete mix at the time of batching the concrete or in accordance with the manufacturer's written procedure and as approved by the Engineer. A copy of the manufacturer's written procedure shall be furnished to the Engineer prior to use of any admixture. Any deviations from the manufacturer's written procedures shall be submitted to the Engineer for approval. Admixtures shall not be added to the concrete with the modified procedures until the Engineer has approved them in writing.

6-02.3(3)A Compatibility

Admixtures from different manufacturers shall not be used together unless the Contractor provides written documentation verifying that the admixtures are compatible in combination with all other ingredients of the concrete.

6-02.3(3)B Air-Entrainment Admixture

An air entraining admixture shall be used to air entrain concrete. Air entrained cement shall not be used.

6-02.3(3)C Water-Reducing Admixture

A water reducing admixture shall be used on Contracting agency provided mixes as shown on the mix design table.

The Contractor may use a set retarding admixture or a combination water reducer and retardant admixture in all Contractor provided mixes. Use of set retarding or reducer/retarder admixtures in Contracting Agency provided mix designs requires the Engineer's approval.

6-02.3(3)D High-Range Water Reducing Admixture

A high-range water reducer (superplasticizer) may be used in all Contractor provided mix designs. The use of a high-range water reducer shall be submitted as a part of the Contractor's concrete mix design.

The Contractor may request the use of a high range water reducer in Contracting Agency-provided mix designs. If the request is approved, the Contractor shall be responsible for the concrete performance as defined in Section 6-02.3(2)A.

6-02.3(4) Ready-Mix Concrete

All concrete, except Commercial Concrete, shall be batched in a prequalified manual, semi-automatic, or automatic plant as described in Section 6-02.3(4)A. If the plant has not been prequalified, the Contractor shall provide written notification to the Engineer two weeks prior to anticipated use of the batch plant to allow for Contracting Agency inspection. Information concerning NRMCA certification may be obtained from the National Ready Mix Concrete Association at 900 Spring Street, Silver Springs, MD 20910. The Engineer is not responsible for any delays to the Contractor due to problems in getting the plant certified.

6-02.3(4)A Qualification of Concrete Suppliers

Prequalification may be obtained through an annual inspection conducted by the Contracting Agency or, as an alternate, through certification by NRMCA, or by an independent evaluation certified by a professional engineer and using NRMCA or

Contracting Agency quidelines. The Contracting Agency inspection and the NRMCA certification have similar requirements for plant and delivery equipment.

For central-mixed concrete, the mixer shall be equipped with a timer that prevents the batch from discharging until the batch has been mixed for the prescribed mixing time. A mixing time of one minute will be required after all materials and water have been introduced into the drum. Shorter mixing time may be allowed if the mixer performance is tested in accordance with Designation 26, Variability of Constituents in Concrete, Concrete Manual, U.S. Department of the Interior (ASTM C94-86b Annex A1 Concrete Uniformity Requirements). Tests shall be conducted by an independent testing lab or by a commercial concrete producer's lab. If the tests are performed by a producer's lab, the Engineer or a representative will witness all testing.

For shrink-mixed concrete, the mixing time in the stationary mixer shall not be less than 30 seconds or until the ingredients have been thoroughly blended.

For transit-mixed or shrink-mixed concrete, the mixing time in the transit mixer shall be a minimum of 70 revolutions at the mixing speed designated by the manufacturer of the mixer. Following mixing, the concrete in the transit mixer may be agitated at the manufacturer's designated agitation speed. A maximum of 320 revolutions (total of mixing and agitation) will be permitted prior to discharge.

All transit-mixers shall be equipped with an operational revolution counter and a functional device for measurement of water added. All mixing drums shall be free of concrete buildup and the mixing blades shall meet the minimum specifications of the drum manufacturer. A copy of the manufacturer's blade dimensions and configuration shall be on file at the concrete producer's office. A clearly visible metal data plate (or plates) attached to each mixer and agitator shall display: (1) the maximum concrete capacity of the drum or container for mixing and agitating, and (2) the rotation speed of the drum or blades for both the agitation and mixing speeds. Mixers and agitators shall always operate within the capacity and speed-of-rotation limits set by the manufacturer. Any mixer, when fully loaded, shall keep the concrete uniformly mixed. All mixers and agitators shall be capable of discharging the concrete at a steady rate. Only these transit-mixers which meet the above requirements will be allowed to deliver concrete to any state project covered by these Specifications.

In transit-mixing, mixing shall begin within 30 seconds after the cement is added to the aggregates.

Central-mixed concrete, transported by truck mixer/agitator, shall not undergo more than 250 revolutions of the drum or blades before beginning discharging. To remain below this limit, the suppler may agitate the concrete intermittently within the prescribed time limit. When water or admixtures are added after the load is initially mixed, an additional 30 revolutions will be required at the recommended mixing speed.

For each project, at least biannually, or as required, the Engineer will examine mixers and agitators to check for any buildup of hardened concrete or worn blades. If this examination reveals a problem, or if the Engineer wishes to test the quality of the concrete, slump tests may be performed with samples taken at approximately the 1/4 and 3/4 points as the batch is discharged. The maximum allowable slump difference shall be as follows:

If the average of the two slump tests is ≤4 inches, the difference shall be ≤1 inch or if the average of the two slump tests is >4 inches, the difference shall be ≤1 1/2 inches.

If the slump difference exceeds these limits, the equipment shall not be used until the faulty condition is corrected. However, the equipment may continue in use if longer mixing times or smaller loads produce batches that pass the slump uniformity tests.

All concrete production facilities will be subject to verification inspections at the discretion of the Engineer. Verification inspections are a check for: current scale certifications; accuracy of water metering devices; accuracy of the batching process; and verification of coarse aggregate quality for Contractor-provided mix designs.

If the concrete producer fails to pass the verification inspection, the following actions will be taken:

1. For the first violation, a written warning will be provided.

2. For the second violation, the Engineer will give written notification and the State will accept the concrete with a price reduction equal to 15 percent of the invoice cost of the concrete that is supplied from the point of the infraction until the deficient condition is corrected.

3. For the third violation, the concrete supplier is suspended from providing concrete until all such deficiencies causing the violation have been permanently corrected and the plant and equipment have been reinspected and meets all the prequalification requirements.

4. For the fourth violation, the concrete supplier shall be disqualified from supplying concrete for one year from the date of disqualification. At the end of the suspension period the concrete supplier may request that the facilities be inspected for prequalification.

6-02.3(4)B Hand Mixing

The Contractor shall not hand mix concrete except in emergencies and then only with written permission from the Engineer. Hand mixing is never permitted for concrete to be placed in water.

If the Engineer permits, hand mixing shall be done on a watertight platform in a way that distributes materials evenly throughout the mass. Mixing shall continue long enough to produce a uniform mixture. No hand mixed batch shall exceed 1/2 cubic yard.

6-02.3(4)C Consistency

The maximum slump for concrete shall be:

1. 3.5 inches for vibrated concrete placed in all bridge roadway slabs, bridge approach slabs, and flat slab bridge superstructures.

2. 4.5 inches for all other vibrated concrete.

3. 7 inches for non-vibrated concrete. (Includes Class 4000P)

When a high range water reducer is used, the maximum slump listed above may be increased an additional 2 inches while the concrete is affected by the admixture.

6-02.3(4)D Temperature and Time For Placement

Concrete temperatures shall remain between 60F and 90F while it is being placed.

The batch of concrete shall be discharged at the project site no more than 1.5 hours after the cement is added to the concrete mixture. The time to discharge may be extended to 1.75 hours if the temperature of the concrete being placed is less than 75F. With the approval of the Engineer and as long as the temperature of the concrete being placed is below 75F, the maximum time to discharge may be extended to two hours. When conditions are such that the concrete may experience an accelerated initial set, the Engineer may require a shorter time to discharge.

6-02.3(4)E Air-Entrainment

Air content shall be between 4.5 percent and 7.0 percent for all concrete placed above the finished ground line. Air entrained concrete will be permitted for use below finished ground line provided the Contractor assumes responsibility for compressive strength.

6-02.3(5) Acceptance of Concrete

6-02.3(5)A General

Lean concrete and commercial concrete will be accepted based on a Certificate of Compliance, to be provided by the supplier as described in Section 6-02.3(5)B.

Concrete made in accordance with a Contracting Agency-provided mix design will be accepted based on conformance to the specified requirements for proportioning, temperature, air content for concrete placed above finished ground line, and slump. Concrete accepted with minor deviations in accordance with Section 6-02.3(5)J, for air content deviation and slump deviation, will also be accepted based on its 28 day compressive strengths.

Concrete made in accordance with a Contractor-provided mix design will be accepted based on conformance to the requirement for temperature, slump, air content for concrete placed above finished ground line, or as adjusted by the appropriate price adjustment for air content deviation and slump deviation, and the specified compressive strength at 28 days for sublots as tested and determined by the Contracting Agency.

A sublot is defined as the material represented by an individual strength test. An individual strength test is the average compressive strength of two cylinders from the same sample of material.

Each sublot will be deemed to have met the specified compressive strength requirement when both of the following conditions are met:

1. Individual strength tests do not fall below the specified strength by more than 12 1/2 percent or 500 psi, whichever is least.

2. An individual strength test averaged with the two preceding individual strength tests meets or exceeds the specified strength. (For the same class of concrete on the same contract).

When compressive strengths fail to satisfy the above requirements, the Contractor may:

1. Request acceptance based on the Contractor/Suppliers strength test data for cylinders made from the same truckload of concrete as the Contracting Agency cylinders; provided the Contractor's test results are obtained from testing cylinders fabricated, handled, and stored for 28 days in accordance with WSDOT Test Method No. 809.

2. Request acceptance of in-place concrete strength based on core results. This method will not be used if the Engineer determines coring would be harmful to the integrity of the structure. Cores, if allowed, will be obtained by the Contractor in accordance with AASHTO T 24 and delivered to the Contracting Agency for testing in accordance with AASHTO T 22. If the concrete in the structure will be dry under service conditions, the core will be air dried at a temperature of 60-80 F, and at a relative humidity of less than 60 percent, for seven days before testing and will be tested air dry.

   Acceptance for each sublot by the core method requires that the average compressive strength of three cores be at least 85 percent of specified strength with no one core less than 75 percent of specified strength. When the Contractor requests strength analysis by coring, the results obtained will be accepted by both parties as conclusive and supersede all other strength data for the concrete sublot.

   If the Contractor elects to core, cores shall be obtained no later than 56 days after initial concrete placement. The Engineer will concur in the locations to be cored. Repair of cored areas shall be the responsibility of the Contractor. The cost incurred in coring, including repair of core locations, shall be borne by the Contractor unless core strength results prove acceptable. The Contracting Agency will pay for the costs under the provisions of Section 1-05.6, paragraph 4 when strength results for the sublots are acceptable.

6-02.3(5)B Certification of Compliance

Cement Producer, Type, and Mill Test No. (The mill test number as required by Section 9-01.3 is the basis for acceptance of cement.)

The concrete producer shall provide a Certificate of Compliance for each truckload of concrete. The Certificate of Compliance shall verify that the delivered concrete is in compliance with the mix design and shall include:

Manufacturer Plant (Batching Facility)
Contracting Agency Contract No.
Date
Time Batched
Truck No.
Initial Revolution Counter Reading
Quantity (Quantity batched this load)

Type of concrete by class and producer design mix number
Cement Producer, Type, and Mill Test No. (The mill test number as required by Section 9-01.3 is the basis for acceptance of cement.)
Fly Ash (if used) Brand and Type
Approved aggregate gradation designation

Mix Design weights per cubic yard and actual batched weights for:

Cement
Fly Ash (if used)
Coarse Concrete Aggregate and moisture content (each size)
Fine Concrete Aggregate and moisture content
Water (including free moisture in aggregates)
Admixtures brand, quantity per/100 wt., and total quantity batched
- Air-Entraining Admixture
- Water Reducing Admixture
- Other Admixture

The Certificate of Compliance shall be signed by a responsible representative of the concrete producer, other than the driver, affirming the accuracy of the information provided. In lieu of providing a machine produced record containing all of the above information, the concrete producer may use the Contracting Agency-provided printed forms, which shall be completed for each load of concrete delivered to the project.

6-02.3(5)C Conformance to Mix Design

Aggregate weights shall conform within plus or minus 2 percent of the weights for course and fine aggregate required by the mix design. The total cementitious material weight shall conform within plus or minus 1 percent of the mix design weight. If the total cementitious material weight is made up of different components, these component weights shall be within the following tolerances:

1. Portland cement plus or minus 1 percent of the mix design weight.
2. Fly ash plus or minus 5 percent of the mix design weight.
3. Microsilica plus or minus 10 percent of the mix design weight.

Water measured by volume or weight shall conform within plus or minus 1.5 percent of the mix design amount but shall, in no case, exceed the maximum water specified in the Contracting Agency-provided mix design.

All weights shall conform to the mix design weights or as modified in accordance with Section 6-02.3(2)C.

6-02.3(5)D Test Methods

Acceptance testing will be performed by the Contracting Agency in accordance with WSDOT Standard Test Methods as set forth in the WSDOT Laboratory Manual. WSDOT Standard Test Methods to be used with this specification are:

801 Method of Test for Compressive Strength of Molded Cylinders
803 Method of Sampling Fresh Concrete
804 Method of Test for Slump of Portland Cement Concrete
805 Method of Test for Determination of percent of Entrained Air in Portland Cement Concrete
806 Method of Test for Weight Per Cubic Foot and Cement Factor of Concrete

809 Method of Making, Handling, and Storing Concrete Compressive Test Specimens in the Field
811 Method of Capping Cylindrical Concrete Specimens

The Contractor may observe any of the sampling and testing performed by the Engineer. If the Contractor observes a deviation from the specified sampling or testing procedures, the Contractor shall verbally describe the deviations observed to the Engineer or designated representative immediately, and shall confirm these observed deviations in writing to the Engineer within 24 hours. The Engineer will respond in writing within three working days of the receipt of the Contractor's written communication.

6-02.3(5)E Point of Acceptance

Determination of concrete properties for acceptance will be made based on samples taken as follows:

Bridge decks, overlays, and barriers at the discharge of the placement system.

All other placements at the truck discharge.

It shall be the Contractor's responsibility to provide adequate and representative samples of the fresh concrete to a location designated by the Engineer for the testing of concrete properties and making of cylinder specimens. Samples shall be provided as directed in Sections 1-06.1 and 1-06.2.

6-02.3(5)F Water/Cement Ratio Conformance

The actual water cement ratio shall be determined from the certified proportions of the mix, adjusting for on the job additions. No water may be added after acceptance testing or after placement has begun, except for concrete used in slip forming. For slip-formed concrete, water may be added during placement but shall not exceed the maximum water cement ratio in the mix design, and shall meet the requirements for consistency as described in Section 6-02.3(4)C. If water is added, an air and temperature test shall be taken prior to resuming placement to ensure that specification conformance has been maintained.

6-02.3(5)G Sampling and Testing Frequency for Temperature, Consistency, and Air Content

Concrete properties shall be determined from concrete as delivered to the project and as accepted by the Contractor for placement. The Contracting Agency will test for acceptance of concrete for slump, temperature, and air content, if applicable, as follows:

Sampling and testing will be performed before concrete placement from the first truck load. Concrete shall not be placed until tests for slump, temperature, and entrained air (if applicable) have been completed by the Engineer and the results indicate that the concrete is within acceptable limits. Except for the first load of concrete, up to 1/2 cubic yard may be placed prior to testing for acceptance. Sampling and testing will continue for each load until two successive loads meet all applicable acceptance test requirements. After two successive tests indicating that the concrete is within specified limits, the sampling and testing frequency may decrease to one for every five truck loads. Loads to be sampled will be selected in accordance with the random selection process as outlined in WSDOT Test Method 803 Section 4.

When the results for any subsequent acceptance test indicates that the concrete as delivered and approved by the Contractor for placement does not conform to the specified limits the sampling and testing frequency will be resumed for each truck load. Whenever two successive subsequent tests indicate that the concrete is within the specified limits, random sampling and testing frequency at one for every five truck loads may resume.

Sampling and testing for a placement of one class of concrete consisting of 50 cubic yards or less will be as listed above, except:

Sampling and testing will continue until one load meets all of the applicable acceptance requirements, and

After one set of tests indicate that the concrete is within specified limits, the remaining concrete to be placed may be accepted by visual inspection.

6-02.3(5)H Sampling and Testing for Compressive Strength

CONTRACTOR PROVIDED MIX DESIGN

Acceptance testing for compressive strength for concrete produced in accordance with a Contractor-provided mix design or Commercial concrete shall be conducted at the same frequency as the acceptance tests for temperature, consistency, and air content.

CONTRACTING AGENCY PROVIDED MIX DESIGN

For concrete produced in accordance with a Contracting Agency-provided mix design, compressive strength tests specimens shall be made at a frequency of approximately every five truck loads unless the Contractor elects to place this concrete as part of the minor deviation material allowed in Section 6-02.3(5)I. Specimens for acceptance of compressive strength of deviant material shall be made at the same frequency as for Contractor provided mixes. Specimens for compressive strength testing shall only be made from concrete that is accepted for placement.

6-02.3(5)I Limited Acceptance of Deviant Material

A limited number of loads of Ready-Mix concrete may be accepted having minor deviations from the Specification limits with an appropriate price adjustment. Placement of 10 loads or less may not include more than 3 loads with minor deviations. Placements involving more than 10 loads shall not have more than 1 additional load within these limits for each additional 5 loads, or fractions thereof. A placement shall consist of all concrete of a given strength class placed during a 24 hour day.

All concrete whose slump and/or air content if applicable deviates more than the allowed minor amount and all loads in excess of the permissible number per placement will be rejected and shall be removed if placed before testing is complete.

6-02.3(5)J Minor Deviations (Optional Placement with Price Adjustment)

Within the above stated number of loads, concrete which exceeds the maximum slump by 1/2 inch or less, or which exceeds or is below the applicable air content by 1/2 percent or less will be rejected unless the Contractor elects to place this concrete with a price adjustment. If the Contractor elects to place this concrete, the price adjustment for slump and /or air content deviation shall be calculated in accordance with the price adjustment calculation specified below. Should the concrete fail to meet

the specified 28-day compressive strength (f'c), the concrete will be evaluated as concrete with non-conforming strength in accordance with Section 6-02.3(5)L.

Price Adjustment = U.P.[1/2 (1-P.F.)]V

where P.F. = pay factor tabulated below
U.P. = unit contract price per cubic yard for the class of concrete involved
V = cubic yard volume of concrete in the tested load based on the certificate of compliance or as estimated for a partial load

Where these specifications designate the payment for the concrete on other than a per cubic yard basis, the unit contract price (U.P.) of concrete shall be taken as $300 per cubic yard for concrete Class 4000 and higher and $160 per cubic yard for concrete Class 3000 and commercial concrete.

Pay factors for adjusting the concrete price for acceptance due to air content deviation and excess slump are:

PAY FACTORS

Deviations From Specified % Air	Pay Factor	Maximum Slump Exceeded by	Pay Factor
Up to 0.3%	0.98	1/4"	0.98
0.3 - 0.5%	0.96	1/2"	0.96

*All concrete with an air content less than 4% shall be rejected.

If deviations occur in the air content and slump within the same testing frequency quantity, the pay factor shall be the product of the individual pay factors. The following table lists the product of pay factors to be used:

PRODUCT OF PAY FACTORS
0.98 X 0.98 = 0.96
0.98 X 0.96 = 0.94
0.96 X 0.96 = 0.92

6-02.3(5)K Rejecting Concrete

Rejection by Contractor - The Contractor may, prior to sampling, elect to remove any defective material and replace it with new material at the Contractor's expense. Any such new material will be sampled, tested, and evaluated for acceptance.

Rejection Without Testing - The Engineer, prior to sampling, may reject any batch or load of concrete that appears defective in composition; such as cement content or aggregate proportions. Rejected material shall not be incorporated in the structure.

6-02.3(5)L Concrete With Non-Conforming Strength (Contractor Design or Commercial)

Concrete produced in accordance with a Contractor-provided mix design or Commercial Concrete with cylinder compressive strength (fc) which fails to meet acceptance level requirements shall be evaluated for structural adequacy. If the

material is found to be adequate, payment shall be adjusted in accordance with the following formula:

$$\text{Payment Adjustment} = \frac{2(f'c - fc)(UP)(Q)}{f'c}$$

where
- f'c = Specified minimum compressive strength at 28 days.
- fc = Compressive strength at 28 days as determined by WSDOT Test Methods.
- UP = Unit contract price per cubic yard for the class of concrete involved.
- Q = Quantity of concrete represented by an acceptance test based on the required frequency of testing.

Concrete that fails to meet minimum acceptance levels using the coring method will be evaluated for structural adequacy. If the material is found to be adequate, payment shall be adjusted in accordance with the following formula:

$$\text{Payment Adjustment} = \frac{3.56(.85f'c - f\ cores)(UP)(Q)}{f'c}$$

where
- f'c = Specified minimum compressive strength at 28 days.
- f cores = Compressive strength at 28 days as determined by WSDOT Test Methods.
- UP = Unit contract price per cubic yard for the class of concrete involved.
- Q = Quantity of concrete represented by an acceptance test based on the required frequency of testing.

Where these Specifications designate payment for the concrete on other than a per cubic yard basis, the unit contract price of concrete shall be taken as $300 per cubic yard for concrete Class 4000, 5000, and 6000. For concrete Class 3000 the unit contract price for concrete shall be $160 per cubic yard.

6-02.3(5)M Concrete With Non-Conforming Strength (Contracting Agency Provided)

Contracting Agency-provided mix design concrete placed in conformance with the specifications which fails to meet the specified 28-day compressive strength (f'c) will be evaluated by the Engineer for acceptance.

The Engineer and the Contractor shall review all the production records, the concrete producer's certificates of compliance, test records, field notes, and the placement records for the concrete in question. If the review confirms that the concrete as produced and placed conforms to the specified requirements, the Contracting Agency will accept the concrete. If, however, the review indicates that the concrete was not produced within the specified requirements and/or was not placed in accordance with the specifications, the concrete in question will be evaluated as concrete with non-conforming strength in accordance with Section 6-02.3(5)L. Concrete with minor deviations in slump and/or air content, which the Contractor has elected to place in

accordance with Sections 6-02.3(5)I and 6-02.3(5)J, shall be evaluated for strength in accordance with Section 6-02.3(5)L. The Contractor has the opportunity to supply additional information related to the actual 28 day compressive strength.

6-02.3(6) Placing Concrete

The Contractor shall not place concrete:

1. On frozen or ice-coated ground or subgrade;

2. Against or on ice-coated forms, reinforcing steel, structural steel, conduits, precast members, or construction joints;

3. Under rainy conditions; placing of concrete shall be stopped before the quantity of surface water is sufficient to affect or damage surface mortar quality or cause a flow or wash of the concrete surface;

4. In any foundation until the Engineer has approved its depth and character;

5. In any form until the Engineer has approved it and the placement of any reinforcing in it; or

6. In any work area when vibrations from nearby work may harm the concrete's initial set or strength.

When a foundation excavation contains water, the Contractor shall pump it dry before placing concrete. If this is impossible, an underwater concrete seal shall be placed that complies with Section 6-02.3(6)B. This seal shall be thick enough to resist any uplift.

All foundations and forms shall be moistened with water just before the concrete is placed. Any standing water on the foundation or in the form shall be removed.

The Contractor shall place concrete in the forms as soon as possible after mixing. The concrete shall always be plastic and workable. For this reason, the Engineer may reduce the time to discharge even further. Concrete placement shall be continuous, with no interruption longer than 30 minutes between adjoining layers unless the Engineer approves a longer time. Each layer shall be placed and consolidated before the preceding layer takes initial set. After initial set, the forms shall not be jarred, and projecting ends of reinforcing bars shall not be disturbed.

In girders or walls, concrete shall be placed in continuous, horizontal layers 1.5 to 2 feet deep. Compaction shall leave no line of separation between layers. In each part of a form, the concrete shall be deposited as near its final position as possible.

Any method for placing and consolidating shall not segregate aggregates or displace reinforcing steel. Any method shall leave a compact, dense, and impervious concrete with smooth faces on exposed surfaces. Plastering is not permitted. Any section of defective concrete shall be removed at the Contractor's expense.

To prevent aggregates from separating, the length of any conveyor belt used to transport concrete shall not exceed 300 feet. If the mix needs protection from sun or rain, the Contractor shall cover the belt. When concrete pumps are used for

placement, the operator(s) shall be certified by the American Concrete Pumping Association for the type of equipment and class of concrete to be placed. Prior to use on the first placement of each day a Contractor's representative shall visually inspect the pumps water chamber for water leakage. No pump shall be used that allows free water to flow past the piston.

If a concrete pump is used as the placing system, the pump priming slurry shall be discarded before placement. Initial acceptance testing may be delayed until the pump priming slurry has been eliminated from the concrete being pumped. Eliminating the priming slurry from the concrete may require that several cubic yards of concrete are discharged through the pumping system and discarded. Use of a concrete pump requires a reserve pump (or other backup equipment) at the site to prevent missed deadlines from breakdowns.

If the concrete will drop more than 5 feet, it shall be deposited through a sheet metal (or other approved) conduit. If the form slopes, the concrete shall be lowered through approved conduit to keep it from sliding down one side of the form. No aluminum conduits or tremies shall be used to pump or place concrete.

Before placing concrete for roadway slabs on steel spans, the Contractor shall release the falsework under the bridge and let the span swing free on its supports. Concrete in flat slab bridges shall be placed in one continuous operation for each span or series of continuous spans.

Concrete for roadway slabs and the stems of T-beams or box-girders shall be placed in separate operations if the stem of the beam or girder is more than 3 feet deep. First the beam or girder stem shall be filled to the bottom of the slab fillets. Roadway slab concrete shall not be placed until enough time has passed to permit the earlier concrete to shrink (at least 12 hours). If stem depth is 3 feet or less, the Contractor may place concrete in one continuous operation if the Engineer approves.

Between expansion or construction joints, concrete in beams, girders, roadway slabs, piers, columns, walls, and traffic and pedestrian barriers, etc., shall be placed in a continuous operation.

No traffic or pedestrian barrier shall be placed until after the roadway slabs are complete for the entire structure. No concrete barriers shall be placed until the falsework has been released and the span supports itself. No barrier, curb, or sidewalk shall be placed on steel or prestressed concrete girder bridges until the roadway slab reaches a compressive strength of at least 3,000 psi.

The Contractor may construct traffic and pedestrian barriers by the slipform method. However, the barrier may not deviate more than 1/4 inch when measured by a 10-foot straightedge held longitudinally on the front face, back face, and top surface. Electrical conduit within the barrier shall be constructed in accordance with the requirements of Section 8-20.3(5).

When placing concrete in arch rings, the Contractor shall ensure that the load on the falsework remains symmetrical and uniform.

Unless the Engineer approves otherwise, arch ribs in open spandrel arches shall be placed in sections. Small key sections between large sections shall be filled after the large sections have shrunk.

6-02.3(6)A Weather and Temperature Limits to Protect Concrete

HOT WEATHER PROTECTION

The Contractor shall provide concrete within the specified temperature limits by:

1. Shading or cooling aggregate piles (sprinkling of fine aggregate piles with water is not allowed). If sprinkling of the coarse aggregate is to be used, the piles moisture content shall be monitored and the mixing water adjusted for the free water in the aggregate. In addition, when removing the coarse aggregate, it shall be removed from at least 1 foot above the bottom of the pile.

2. Refrigerating mixing water; or replacing all or part of the mixing water with crushed ice, provided the ice is completely melted by placing time.

If the concrete would probably exceed 90F using normal methods, the Engineer may require approved temperature-reduction measures be taken before the placement begins.

If air temperature exceeds 90F, the Contractor shall use water spray or other approved methods to cool all concrete-contact surfaces to less than 90F. These surfaces include forms, reinforcing steel, steel beam flanges, and any others that touch the mix. The Contractor shall reduce the time between mixing and placing to a minimum and shall not permit mixer trucks to remain in the sun while waiting to discharge concrete. Chutes, conveyors, and pump lines shall be shaded.

If bridge roadway slabs are placed while air temperature exceeds 90F, the Contractor shall:

1. Cover the top layer of reinforcing steel with clean, wet burlap immediately before concrete placement;

2. Sprinkle cool water on the forms and reinforcing steel just before the placement if the Engineer requires it;

3. Finish the concrete slab without delay; and

4. Provide at the site water-fogging equipment to be used if needed after finishing to prevent plastic cracks.

If the evaporation rate at the concreting site is 0.20 pounds per square foot of surface per hour or more (determined from Table 6-02.3(6)), the Contractor shall surround the fresh concrete with an enclosure. This enclosure will protect the concrete from wind blowing across its surface until the curing compound is applied. If casting deck concrete that is 80F or hotter, the Contractor shall install approved equipment at the site to show relative humidity and wind velocity.

COLD WEATHER PROTECTION

The Contractor shall provide a written procedure for cold weather concreting to the Engineer for review and approval. Permission given by the Engineer to place concrete during cold weather will in no way ensure acceptance of the work by the Contracting Agency. Should the concrete placed under such conditions prove unsatisfactory in any way, the Engineer shall still have the right to reject the work although the plan and the work was carried out with the Engineer's permission.

The Engineer may require the Contractor to provide and maintain a recording thermometer near the concreting site. During freezing or near-freezing weather, data from this thermometer shall be readily available to the Engineer.

The Contractor shall not mix nor place concrete while the air temperature is below 35F, unless the water or aggregates (or both) are heated to at least 70F. The aggregate shall not exceed 150F. If the water is heated to more than 150F, it shall be mixed with the aggregates before the cement is added. Any equipment and methods shall heat the materials evenly.

The Contractor may warm stockpiled aggregates with dry heat or steam, but not by applying flame directly or under sheet metal. If the aggregates are in bins, steam or water coils or other heating methods may be used if aggregate quality is not affected. Live steam heating is not permitted on or through aggregates in bins. If using dry heat, the Contractor shall increase mixing time enough to permit the super-dry aggregates to absorb moisture.

Any concrete placed in air temperatures below 35F shall be immediately surrounded with a heated enclosure. Air temperature within the enclosure shall be maintained between 50F and 90F, and the relative humidity shall be above 80 percent. These conditions shall be maintained for a minimum of seven days or for the cure period required by Section 6-02.3(11), whichever is longer. The Contractor shall stop adding moisture 24 hours before removing the heat. Extra protection shall be provided for areas especially vulnerable to freezing (such as exposed top surfaces, corners and edges, thin sections, and concrete placed into steel forms).

If weather forecasts predict air temperatures below 35F during the seven days just after the concrete placement, the Contractor may place the concrete only if it is protected with a heated enclosure.

6-02.3(6)B Placing Concrete in Foundation Seals

If the Plans require a concrete seal, the Contractor shall place the concrete underwater inside a watertight cofferdam, tube, or caisson. Seal concrete shall be placed in a compact mass in still water. It shall remain undisturbed and in still water until fully set. While seal concrete is being deposited, water elevation inside and outside the cofferdam shall remain equal to prevent any flow through the seal in either direction. The cofferdam shall be vented at the vent elevation shown in the Plans. The thickness of the seal is based upon this vent elevation.

The seal shall be at least 18 inches thick unless the Plans show otherwise. The Engineer may change the seal thickness during construction which may require redesign of the footing and the pier shaft or column. Although seal thickness changes may result in the use of more or less concrete, reinforcing steel, and excavation, payment will remain as originally defined in unit contract prices.

To place seal concrete underwater, the Contractor shall use a concrete pump or tremie. The tremie shall have a hopper at the top that empties into a watertight tube at least 10 inches in diameter. The discharge end of the tube on the tremie or concrete pump shall include a device to seal out water while the tube is first filled with concrete. Tube supports shall permit the discharge end to move freely across the entire work area and to drop rapidly to slow or stop the flow. One tremie may be used to concrete an area up to 18 feet per side. Each additional area of this size requires one additional tremie.

Throughout the underwater concrete placement operation, the discharge end of the tube shall remain submerged in the concrete and the tube shall always contain enough concrete to prevent water from entering. The concrete placement shall be continuous until the work is completed, resulting in a seamless, uniform seal. If the concreting operation is interrupted, the Engineer may require the Contractor to prove by core drilling or other tests that the seal contains no voids or horizontal joints. If testing reveals voids or joints, the Contractor shall repair them or replace the seal at no expense to the Contracting Agency.

Concrete Class 4000W shall be used for seals, and it shall meet the consistency requirements of Section 6-02.3(4)C.

6-02.3(6)C Dewatering Concrete Seals and Foundations

After a concrete seal is constructed, the Contractor shall pump the water out of the cofferdam and place the rest of the concrete in the dry. This pumping shall not begin until the seal concrete has set enough to withstand the hydrostatic pressure (three days for gravity seals and ten days for seals containing piling or shafts). The Engineer may extend these waiting periods to ensure structural safety or to meet a condition of the operating permit.

If weighted cribs are used to resist hydrostatic pressure at the bottom of the seal, the Contractor shall anchor them to the foundation seal. Any method used (such as dowels or keys) shall transfer the entire weight of the crib to the seal.

No pumping shall be done during or for 24 hours after concrete placement unless done from a suitable sump separated from the concrete work by a watertight wall. Pumping shall be done in a way that rules out any chance of concrete being carried away.

6-02.3(6)D Vacant

6-02.3(10) Roadway Slabs

The last sentence of the eighteenth paragraph is revised to read:

> An acceptable surface shall be one free from deviations of more than 1/8-inch under the 10-foot straightedge.

6-02.3(11) Curing Concrete

The first paragraph is revised to read:

> After placement, concrete surfaces shall be cured as follows:
>
> 1. Slabs (roadway, except those using Class 4000D and 4000DLS; bridge sidewalks; culvert tops; and roofs of cut and cover tunnels) - curing

compound covered by white, reflective type sheeting or continuous wet curing for at least 10 days.

2. Roadway slabs using concrete Class 4000D and 4000DLS - continuous wet cure with heavy quilted blankets or burlap only, for 14 days.

3. Retaining walls, culvert sidewalls, and culvert floors - continuous moisture for at least 10 days.

4. All other concrete surfaces (except traffic barriers and rail bases) - continuous moisture for at least three days.

The second paragraph is supplemented with the following:

Runoff water shall be collected and disposed of in accordance with all applicable regulations. In no case shall runoff water be allowed to enter any lakes, streams, or other surface waters.

The following paragraph is added after the second paragraph:

Wet curing roadway slabs with heavy quilted blankets or burlap, shall consist of a fog or mist spray covering the entire concrete surface before the bleed water has evaporated. As soon as the concrete has achieved initial set, the surface shall be covered with presoaked heavy quilted blankets or burlap.

The third paragraph is revised to read:

When curing roadway slabs with wet heavy quilted blankets or burlap, a fog or mist spray of water shall be sprayed on the entire concrete surface before the bleed water has evaporated. As soon as the concrete has achieved initial set, the surface shall be covered with presoaked heavy quilted blankets of burlap. The fog or mist spray shall be applied continuously until the presoaked heavy quilted blankets of burlap are placed. If the fog or mist spray can not be applied continuously, two coats of curing compound (that complies with Section 9-23.2) shall be applied after the initial fog or mist spray application and before the presoaked heavy quilted blankets of burlap are placed.

The first sentence of the fourth paragraph is revised to read:

Unless the Plans call for an asphalt overlay, the Contractor shall use white pigmented curing compound (Type 2), agitating it thoroughly just before and during application.

The seventh paragraph is revised to read:

If the Plans call for an asphalt overlay, the Contractor shall use the clear curing compound (Type 1D), applying at least 1 gallon per 150 square feet to the concrete slab.

6-02.3(16) Plans For Falsework and Formwork

The first sentence of the thirteenth paragraph is revised to read:

A State of Washington Professional Engineer, licensed under Title 18 RCW, State of Washington, in the branch of Civil or Structural Engineering may be retained to check, review, and certify falsework and formwork plans and calculations of an

individual who is licensed in another state provided that the following conditions are satisfied:

6-02.3(17)B Allowable Design Stresses and Deflections

In the first paragraph under the heading Steel:, Compression, flexural but not to exceed $0.6F_y$ is revised to read

$$\frac{12{,}000{,}000 \text{ psi}}{Ld/bt}$$

6-02.3(17)J Face Lumber, Studs, Wales, and Metal Forms

The 18th paragraph is revised to read:

All corners shall be beveled 3/4 inch. However, traffic barrier, footings, footing pedestals, and seals need not be beveled unless the Plans require it.

6-02.3(20) Grout for Anchor Bolts and Bridge Bearings

In the first paragraph, "Type II" is revised to read "Type I or II".

In the second paragraph, "4,000 psi @ 3 days" is revised to read "4,000 psi @ 7 days".

In the fifth paragraph, "Type II" is revised to read "Type I or II".

The second sentence in the seventh paragraph is revised to read:

The grout pad shall be cured as recommended by the manufacturer or kept continuously wet with water for three days.

6-02.3(24)C Placing and Fastening

The sixth paragraph is revised to read:

Mortar blocks (or other approved devices) shall be used to maintain the concrete coverage required by the Plans. The Mortar blocks shall:

1. Have a bearing surface measuring not greater than 2 inches in either dimension, and
2. Have a compressive strength equal to that of the concrete in which they are embedded.

The following paragraph is added after the 13th paragraph:

Reinforcing steel bars shall not vary more than the following tolerances from their position shown in the Plans:

Members 10 inches or less in thickness	±1/4 in.
Members more than 10 inches in thickness	±3/8 in.
Except:	
The distance between the nearest reinforcing steel bar surface and the top surface of the roadway deck slab	+1/4 in.
Longitudinal spacing of bends and ends of bars	±1 in.
Length of bar laps	-1 1/2 in.

Embedded length	
No. 3 through No. 11	-1 in.
No. 14 through No. 18	-2 in.
When reinforcing steel bars are to be placed at equal spacing within a plane:	
Stirrups and ties	±1 in.
All other reinforcement	±1 bar dia.

6-02.3(25) Prestressed Concrete Girders

The listing for Deck Bulb Tee Girders in the fourth paragraph is supplemented with the following:

Precast prestressed slabs and precast prestressed ribbed sections shall meet all the requirements of these Specifications for deck bulb tee girders.

6-02.3(25)B Casting

The last sentence of the second paragraph is deleted.

The following paragraph is added after the second paragraph:

Slump shall not exceed 4 inches for normal concrete nor 7 inches with the use of a high range water reducing admixture. The high range water reducer shall meet the requirements of Section 6-02.3(3) and Section 6-02.3(3)D. When the slump exceeds the maximum slump specified, the acceptability of the concrete shall be subject to the provisions of Section 6-02.3(5). The Unit Price (U.P.) of the concrete for precast prestressed members shall be taken as $600 per cubic yard for calculation of the pay adjustment.

In the last sentence of the third paragraph, the Section reference is revised to read:

Section 6-02.3(4)E

6-02.3(25)K Girder Deflection

This section is revised to read:

The Contractor shall check and record the vertical deflection (camber) of each girder upon removal of the girder from the casting bed. If the girder remains in storage for a period exceeding 120 days, the Contractor shall check and record the vertical deflection (camber) within a two week period prior to shipment, but no less than three days prior to shipment. The Contractor shall perform and record each check at a time when the alignment of the girder is not influenced by temporary differences in surface temperature. These records shall be available for the Engineer's inspection, and in the case of girders older than 120 days, shall be transmitted to the Engineer as soon as practical for evaluation of the effect of long term storage on the "D" dimension. These records shall also be included in the Contractor's Prestressed Concrete Certificate of Compliance

The "D" dimensions shown in the Plans are computed girder deflections at midspan based on a time elapse of 120 days after release of the prestressing strands. A Positive (+) "D" dimension indicates upward deflection.

The Contractor shall control the deflection of prestressed concrete girders that are to receive a cast-in-place slab by scheduling fabrication within 120 days of girder erection. If it is anticipated that the girders will be older than 120 days at the time of erection, the Contractor shall submit calculations to the Engineer showing the estimated girder deflection at midspan at the age anticipated for erection. This

submittal shall also include the Contractor's proposal for accommodating any excess camber in the construction. The Contractor shall not proceed with girder fabrication until this submittal is approved by the Engineer. The actual girder deflection at the midspan may vary from the "D" dimension at the time of slab forming by a maximum of plus 1/2 -inch for girder lengths up to 80 feet, and plus 1-inch for girder lengths over 80 feet.

All costs, including any additional Contracting Agency engineering expenses, in connection with accommodating excess girder deflection shall be at the Contractor's expense.

6-02.3(26)A Shop Drawings

The second sentence of the ninth paragraph is revised to read:

These shall be clear, suitable for microfilming, and on permanent sheets that measure 22 by 34 inches or 24 by 36 inches.

6-02.3(26)F Grouting

In the fourth paragraph, "Type II" is revised to "Type I or II".

6-02.4 Measurement

This section is supplemented with the following:

Lean concrete will be measured by the cubic yard for the quantity of material placed per the producer's invoice, except that lean concrete included in other contract items will not be measured.

6-02.5 Payment

In the paragraph following No. 9, the Section reference is revised to read:

Section 6-02.3(5)L

In the paragraph following No. 10, the Section reference is revised to read:

Section 6-02.3(5)J

This section is supplemented with the following:

11. "Lean Concrete", per cubic yard.

Lean concrete, except when included in another bid item, will be paid for at the unit contract price per cubic yard.

12. "Commercial Concrete", per cubic yard.